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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

OAST SPACE THEME WORKSHOP

VOLUME II

(NASA-TM-80007) OAST SPACE THEME WORKSHOP.
VOLUME 2: THEME SUMMARY. 6: ADVANCED
TRANSPORTATION SYSTEMS. A: THEME
STATEMENT. B. 26 APRIL 1976 PRESENTATION.
C. THEME SUMMARY. D. INITIATIVE ACTIONS

N79-15119

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G3/12 42660

THEME SUMMARY

VI. ADVANCED TRANSPORTATION SYSTEMS

- A. THEME STATEMENT
- B. APRIL 26, 1976, PRESENTATION
- C. THEME SUMMARY
- D. INITIATIVE ACTIONS

HELD AT THE
LANGLEY RESEARCH CENTER
APRIL 26-30, 1976



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Foreword

The attached material represents the working papers from the OAST Space Theme Workshop held at the Langley Research Center, April 26-30, 1976, and contains a quick-look analysis of the proceedings. The material is unedited and intended for further use by the participants of the workshop and the planning elements of NASA concerned with space mission research and technology. It should be understood that the data do not represent official plans or positions but are part of the process of evolving such plans and positions.

Nearly 100 of the Agency's top technologists and scientists joined with another 35 theme specialists to produce this working document - a document that provides a technical foundation, including research and technology base candidates, for each of the six space themes.

The material in this report is considered essential to the development of Center initiatives in support of these themes. Copies of the report will be made available to the Center Management Board and the individuals at the Centers responsible for the FY'78 program planning cycle. The timing of this planning activity has caused us to distribute this document in this unedited form. Thus, it possibly contains errors, hopefully, more of a typographical rather than a technological nature. Nonetheless, the information contained is of a high professional level, reflecting the efforts of the workshop participants and will be invaluable to the planning and successful execution of the Agency's near- and far-term advanced technology program.

Stanley R. Sadin
OAST Space Theme Workshop
Chairman
NASA Headquarters
Study, Analysis, & Planning Office
Office of Aeronautics and
Space Technology

Introduction

A. Goal (what)

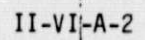
- To assure technology readiness for National needs in the 1985-2000 time period by providing for:
 - Significant reduction in payload delivery cost
 - Performance capability to foster future mission opportunities
 - Operational flexibility to permit exploitation of near-Earth space (including geosynch.)

B. Guidelines and Assumptions (why)

- Mission considerations
 - Initial compatibility with LEO and GEO Space Station/Base (including orbital staging considerations, orbital servicing, etc.)
 - Space power systems
 - Global service systems
 - National security
 - Space industrialization
 - SETI in GEO
- Environment and energy conservation
 - Conservation Earth based energy
 - Minimize propulsion by-products

C. Background/Scope (how)

- Vehicle elements
 - STS
 - STS derivatives
 - OTV family
 - HLLV
 - Advanced vehicles
- Ground operations
 - Launch
 - Mission control
 - Turn-around
- On-orbit operations
 - Assembly
 - Refueling



I. Introduction (WHAT?)

The Advanced Space Transportation Advocacy Theme has defined as its goal: To assure the technology readiness for an integrated space transportation system capability which will permit the Nation to utilize space efficiently, reliably, and routinely in the years between 1985 and 2000, with a significant return on invested resources. Contributing technologies should include those which support:

- a. Total reusability with minimal refurbishment
- b. Responsiveness to high launch rate requirements when operation and energy are the predominant recurring costs.
- c. Maximum flexibility in operation between earth and LEO and between LEO and GEO.

With respect to this stated goal, the objective of the Workshop is to provide information which is useful for technology program planning for future systems which will be needed to support the increasing requirements projected for construction/assembly, manning, and logistics of near-permanent, manned or man-tended facilities operating in both low-earth orbit (LEO) and geosynchronous orbit (GEO).

The precept of this effort is that the technology requirements will build upon the base which will have been established by successful operation of the Space Transportation Systems as

currently defined, i.e, Shuttle, Spacelab, and Interim Upper Stage (IUS) and an advanced upper stage such as the Solar Electric Propulsion Systems (SEPS).

Basic guidelines must also include protection of the environment and conservation of energy.

II. Background (WHY?)

Mission and systems which address national needs and which are currently under study by NASA include Space Stations in LEO and GEO which provide integral or staging support to broader activities such as Multipurpose Space Power Platforms, Space Industrialization, the Search for Extraterrestrial Intelligence, Solar Systems Exploration, and Global Service Systems. The dominant characteristic of the ASTS should support manning and resupply of these activities on a regular basis. However, as a boundary, the ASTS should have the flexibility for rapid response to manned emergencies or critical resupply needs, and the capability to lift very large weights and/or volumes on a non-routine or irregular basis. A typical scenario includes a strawman Space Station (operational schedule is shown in Figure 1), along with the project elements of the ASTS. The initial phase of activity includes a 3-6 man and 10-20 man space stations in LEO supported by the current Space Shuttle in 1983 and 1985 respectively. The second step includes a 3-6 man station in GEO in 1987 and establishes the requirement for a shuttle transportable, manned Orbital Transfer Vehicle (OTV) for rapid transit from LEO to GEO.

Further advances in transportation capability are predicted by the potential for increased utilization of the Space Stations which may be continuously or intermittently manned, or, in some instances, only man-tended for repair or renovation operations.

The advent of a shuttle derived Heavy Lift Launch Vehicle (HLLV) in 1988-90 which utilizes the shuttle booster and orbiter main engines will permit the transportation of large structural elements or consumables to LEO in support of the 3-6 man or 10-20 man space stations operating as core modules or staging bases. The desire for rapid response or delivery of personnel and limited amounts of critical cargo can be met by an advanced earth to LEO vehicle, such as a single-stage-to-orbit concept in the 1990-92 time frame. The necessity for this vehicle is directly proportional to our capability to exploit LEO.

The advent of one OTV, based perhaps on SEPS technology, to move large amounts of cargo from LEO to GEO in order to enhance our capability to exploit this arena

AEROTHERMODYNAMICS

AV

•II-VI-A6

I. Aerothermodynamics

Concern.- Complete understanding of basic flow phenomena.

Objective.- To develop prediction techniques based on a complete understanding of the phenomena to enable the development of accurate design criteria.

Requirement.- The development of optimal aerodynamic designs.

Elements of the Problem

Boundary Layer Transition
Viscous Interaction and Real Gas Effects
Separated Flow
Lee Surface Heating
Windward Heating
Rocket Plume Interference and Base Heating
Base Drag
RCS Interference and Heating
Measurement Techniques

II. Configurations

Concern.- Definition of optimal configuration characteristics.

Objective.- Development of criteria and techniques to achieve an optimal integrated design.

Requirement.- Development of optimal configuration design criteria compatible with mission requirements.

Elements of the Problem

Design Integration
Subsonic/Hypersonic Capability and High Volumetric Efficiency
Control Configured Design

III. TPS

Concern.- Development of materials capable of multi-mission full reusability.

III. TPS (Cont'd)

Objective. - To develop materials, fabrication, and systems capable of reusability.

Requirement. - Increased vehicle utilization at reduced cost.

Elements of the Problem

Catalytic Wall Effects
Reusability
Integrated Thermal Structures

IV. Performance

Concern. - Impact of trajectory and other factors on vehicle design cannot be ascertained without measurements of vehicle performance.

Objective: Development of techniques for real time accurate measurement of the environment and attitude of the vehicle.

Requirements. - Ability to fly an optimal trajectory throughout the entire mission profile to save weight and reduce costs.

VI Boundary Layer Transition

Concern.- Understanding of boundary layer transition.

Objective.- Development of design criteria.

Requirement.- Reduced conservatism in TPS and control system design.

VII Viscous Interaction and Real Gas Effects

Concern.- Understanding of basic phenomena.

Objective.- Improved performance predictions of vehicles.

Requirement.- Elimination of uncertainties in performance predictions and extrapolation of small scale data to flight.

VIII Separated Flow

Concern.- Understanding flow separation characteristics ahead of control surfaces and on lee surfaces.

Objective.- Design of control systems and TPS.

Requirement.- Reduced conservatism and improved design criteria.

IX Lee Surface Heating

Concern.- Develop means for accurately predicting the heating to lee surfaces of complex vehicle shapes.

Objective.- Accurate estimations of lee side heating for design.

Requirement.- Improved design criteria and resulting impact on TPS.

X

Windward Heating

Concern.- Development of means for accurately predicting the heating to the windward surface of complex vehicle shapes.

Objective.- Accurate estimations of windward heating for design.

Requirement.- Improved design criteria and resulting impact on TPS.

XI

Rocket Plume Interference and Base Heating

Concern.- Aerodynamic and heating interference effects.

Objective.- Quantitative estimation capability for these effects.

Requirement.- Vehicle design criteria in areas of performance, stability, control heating, and acoustics.

XII

Base Drag

Concern.- Quantitative estimation of base drag of complex shapes.

Objective.- Develop techniques for accurate estimation and means for reducing base drag.

Requirement.- Improved ascent and recovery performance for aerodynamic type vehicles.

XIII

RCS Interference and Heating

Concern.- Interactive heating, aerodynamic coupling, and vehicle environmental contamination effects.

Objective.- Provide single valved vectoring capability.

Requirement.- Reduced complexity of control system, improved design criteria, and fuel savings.

XIV.

Measurement Techniques

Concern.- Ability to extract useful data from flight.

Objective.- Development of accurate non-obtrusive flight measurement techniques.

Requirement.- Acquisition of data of full scale measurements to verify extrapolation techniques.

XV.

Design Integration

Concern.- Optimal design which considers the interactive effect of all disciplines, systems, and the impact of optimal trajectory guidance.

Objective.- Develop automated design techniques and capabilities to accomplish total design integration.

Requirement.- Maximum system capability at reduced cost.

XVI

Subsonic/Hypersonic Capability and High Volumetric Efficiency

Concern.- Conflicting requirements which lead to design compromises.

Objective.- Development of vehicle design criteria to provide capability for traversing the mission profile in an efficient and controlled manner.

Requirement.- Improve performance and reduce weight of vehicles.

XVII

Control Configured Design

Concern.- Design philosophy for achieving maximum advantages offered by control configured design.

Objective.- Development of design criteria for control configured vehicles.

Requirement.- Improved flight performance of the vehicle at significantly reduced weight.

XVIII

Catalytic Wall Effects

Concern.- Recombination of atomic oxygen at the wall can release large amounts of energy and hence increase the heating.

Objective.- Understand chemical state of boundary layer at the wall.

Requirement.- Improved TPS design.

XIX

Reusability

Concern.- Increased reusability and reduced costs of TPS.

Objective.- Develop improved TPS materials.

Requirement.- Eliminate uncertainties of reusability and improve reliability.

XV

Interdisciplinary

Integrated Structures

Concern.- The development of lightweight structures which perform multiple roles of load bearing, tankage, and TPS.

Objective.- Develop approaches, i.e., hot structures, insulated, or a combination, to achieve lightweight integrated designs.

Requirement.- Develop lightweight long life inspectability, and efficient packaging structures, all of which lead to lower costs.

AEROTHERMODYNAMICS

OTV

II-VI-A-14

I

Nuclear Waste Disposal

Concern.- Large heat shield mass fraction is required

Objective.- Develop heat shield, impact, and shielding technology to withstand abort entry heating and subsequent impact.

Requirement.- Develop safe disposal packages to withstand abort reentry impact. Lower heat shield mass fractions.

II

Ad-Hoc Payload Return

Concern.- Return to Earth of massive structures exceeding shuttle capability.

Objective.- To develop techniques to permit the safe return to the Earth of large structures such as a part of satellite power station.

Requirement.- Enable NASA to return to Earth at will those items deemed necessary.

III

Aero-Braking/OTV

Concern.- Heating is governed by rate processes and requires tailoring by trajectory shaping.

Objective.- To develop the aerothermo technology to enable orbital transfer.

Requirement.- To achieve the proper mix of aero braking and propulsion to provide efficient OT.

IV.

Direct Geosynch to Earth Manned Transfer

Concern.- A manned geosynch to Earth return vehicle carrying 4-10 persons to provide safe entry of the Earth's atmosphere at speeds of 36,000 fps is required.

Objective.- To develop a large lifting vehicle capable of withstanding radiative heating loads.

Requirement.- Heat shield configuration to survive manned Earth reentry.

AEROTHERMODYNAMICS

HLLV

IT-VI-A-17

Ballistic Return

Concern.- Assure safe return to launch site of propulsive package.

Objective.- To develop improved prediction techniques to target flyback stage back to launch site.

Requirement.- Assure aerodynamic stability of configuration to achieve safe return.

Flyback/Glideback

Concern.- To understand base heating and aerodynamics of propulsion assisted gliding vehicles.

Objective.- Develop aerothermodynamic technology to predict the aerodynamic characteristics and leeside heating of propulsive assisted glide vehicles.

Requirement.- Eliminate uncertainties of vehicle range and permit accuracy retrieval prediction.

ADVANCED SPACE TRANSPORTATION SYSTEMS

II CRITICAL MATERIALS TECHNOLOGY ISSUES

Heavy Lift Launch Vehicles

TPS materials for ascent base heating & entry - reusable
with minimum maintenance

Materials compatibility with sea water for landing &
recovery

Orbital Transfer Vehicles

Long-term integrity of composites in space environments

Thermal control - coatings, TPS, heat pipes

Materials compatibility with propellants

Single Stage to Orbit

Advanced materials for integrated TPS, structures, tankage

Resin & metal matrix composites

High-temperature honeycomb materials

RSI & Metallic TPS materials

Materials compatibility with propellants (Ti with LOX?)

ADVANCED SPACE TRANSPORTATION SYSTEMS

IIA STRUCTURES TECHNOLOGY ISSUES

VEHICLE CLASS/CHARACTERISTICS

Heavy Lift Launch Vehicles

- 1 - Shuttle Derivative P/L \approx 150Klb. 1985
Water landing & recovery of booster engines & propellant tanks
- 2 - New Vehicle P/L \approx 500Klb. 1995
Ballistic one or two-stage or winged two-stage
Completely reusable - water or land landing

Single Stage to Orbit Vehicle

P/L \approx 40Klb. 1995
Completely reusable, no refurbishment between flights. Horizontal land landing.

Orbital Transfer Vehicles

- 1 - IUS Derivative + SEPS 1987
Orbital assembly of IUS stages & SEPS for planetary missions
- 2 - OTV for geosynch. space station 1987
Two-stage orbital assembly-aerobraking return from geosynch.
- 3 - OTV for large space facilities >1990
geosynch., lunar, and beyond

CRITICAL STRUCTURES TECHNOLOGIES

Vertical landing impact loads and attenuation (water and land landings)

Large parachutes

High-Temperature structures

Thermal protection systems

Integrated structure, tankage, TPS.
Long life, minimum maintenance
Advanced high-temperature metallic and composite structures
Light-weight landing gear
NDE for assuring integrity between flights

Orbital structural assembly
Long-life thin gage metal and composite structures
Integral structure-propellant tanks
Light-weight solar array structures
Deployable aerobrake structures
NDE for assuring integrity in orbit

III.

GUIDANCE, NAVIGATION, & CONTROL TECHNOLOGY ISSUE MATRIX

I. AUTOMATED CHECKOUT/STATUS SYSTEMS

- ON ORBIT
- PRELAUNCH
- RECYCLE, REFURBISH

II. REAL TIME FLIGHT REGIME OPTIMIZATION

- TRAJECTORY
- CONFIGURATIONS CONTROL
- CONSUMABLES

III. IMPROVED G, N, & C COMPONENTS

- IMPROVED RELIABILITY
- FAULT TOLERANT LOGIC SYSTEMS
- INCREASED INTERVAL BETWEEN MAINTENANCE OPERATIONS
- INCREASED POINTING ACCURACY
- *Lower Cost Hardware & Software*

IV. REDUCED GROUND SUPPORT REQUIREMENTS

- AUTONOMOUS NAVIGATION
- ONBOARD TRACKING & DOCKING DETERMINATIONS

V. Remote Manipulators

- *P/L Servicing*
- *ON-ORBIT maint.*

VI. Automated Mission Planning

- *P/L*

IV. Power/Propulsion

Orbital Transfer Vehicle (OTV) Class -

Space Power

(A) Description of Problems - Provide the technology base to support both current and future space programs requiring greater power capability, life and versatility.

(B) Objectives -

- (1) Support for current NASA program goals through 1991.
- (2) Develop the technical capability to implement an aggressive space station program, including geosynchronous operations by 1987.

(3) Define potential space system capabilities to support ambitious goals beyond 1990:

- (a) Solar system exploration
- (b) Construction of large facilities in LEO and GEO.
- (c) Satellite power station network
- (d) Lunar orbit and surface operations
- (e) Nuclear waste disposal

Requirements.-

Technology Concerns (Issues).-

- a. Delivery and deployment of large space structure.
- b. Usable life of power components (i.e., solar cells and battery).

- c. In-space servicing and refurbishment of power components.
- d. Safety aspects of microwave energy transmission.

Space Propulsion -

(A) Description of Problems - Provide the technical upgrading capability in areas of solid rocket motors, liquid chemical propulsion, and space electric propulsion systems to accomplish future OTV and Lunar Transfer Vehicle missions.

(B) Objectives -

- (1) Improve solid motor performance.
- (2) Integrate propulsive subsystems with other "onboard" energy systems where desirable.
- (3) Develop techniques to permit on-orbit assembly of propulsive stages.
- (4) Improved basic electric thruster system components.

Requirements -

- a. Advancement of overall propulsion technology
- b. Capability to provide reusable chemical propulsion systems for OTV applications.

Technology Concerns (Issues) -

- a. Long life, reusable chemical propulsion components and sub-systems; space based operations; Lunar orbit and surface operations.
- b. Space based electrical propulsion and power subsystem life and reusability.
- c. Orbital facility for propulsion subsystem testing and demonstrations.

d. Mass drivers

e. Nuclear waste as a propulsive energy source

Advanced Vehicles

Shuttle Growth

Space Power -

Description of Problem - Provide technology for improved space power capability, reusability, longer life and higher energy density systems for application to advanced space vehicle concepts.

Objectives - Provide demonstration of higher energy H_2-O_2 auxiliary power unit for an uprated shuttle system.

Requirements - Provide higher performance power subsystem.

Technology Concerns (Issues) -

- a. H_2-O_2 APU flight demonstration.
- b. High density rechargeable batteries
- c. Long life, commercial grade reactant fuel cell demonstrations.
- d. Integration of "common reactant" energy subsystems (i.e., RCS, APU fuel cells and life support systems)

Space Propulsion -

Description of Problem - Provide propulsion technology advancements to permit consideration of uprating the Space Shuttle Vehicle.

Objective - Develop propulsion components for SSME, RCS/OMS and SRM performance improvements and cost reductions.

Requirements - Technological advancements in SSME, RCS/OMS and SRM have a readiness need date of approximately 1985.

Technology Concerns (Issues)

- a. Lower cost non-polluting solid propellants
- b. Low cost, non-toxic RCS OMS propellants
- c. Two-position SSME nozzle
- d. Lightweight cryogenic feedlines (composites)
- e. Low cost SRM replacements (liquids)
- f. Longer life SSME components
- g. Higher density cryogenic propellants (slush H_2-O_2)

Advanced Shuttle-Type Vehicle (SSTO)

Space Power -

Same as uprated shuttle.

Space Propulsion

Description - Provide advanced propulsion approach to accommodate the advanced vehicle concepts evolving during the 1990's.

Objective - Develop the component and subsystem technology required to design and demonstrate advanced propulsion system concepts.

Requirements - High performance main and auxiliary propulsion systems are required to make feasible a single stage to orbit vehicle concept, i.e., 475-500 sec, I_{sp} and high density impulse concepts, i.e.

Technology Concerns (Issues) -

- a. Slush cryogenics
- b. Idle mode main engines
- c. High density liquid engines
- d. Dual mode engine concepts

- e. Dual fuel engine concepts
- f. Zero NPSH pumps
- g. Common reactant RCS/OMS/fuel cell integration
- h. Altitude compensation nozzles
 - (1) Two position
 - (2) Aerospike (linear
- i. Long life (up 500 reuses)

Heavy Launch Lift Vehicles (HLLV)

Description - Same as Adv. Shuttle.

Objectives - Provide tech. for very large HLLV payload > 500,000 lbs.

Requirements - Provide propulsion technology advances to accommodate the HLLV class of vehicle.

Technology Concerns (Issues) -

- a. Tripropellant systems
- b. Plug Custer systems
- c. Ducted - rocket torroidal engines
- d. Linear engines
- e. Larger SRM's
- f. Large high density liquid engines
- g. Super cheap throw-away boosters
- h. Integrated ACS systems

V.

GROUND OPERATIONS COST REDUCTION

Ground operations constitute a major area of cost reduction potential. Saturn Apollo prelaunch preparations at the launch site required several months to accomplish. The Space Shuttle Program requires a turnaround of the orbiter in 160 hours. In each case, less than 15% of the launch preparation time is spent in "power-on" testing.

Ongoing avionics technology growth is contributing to shortening of the "power-on" testing requirements. Substantial improvement must be realized in the other 85% of the required preparation time to effectively cut ground operations cost. The drivers in this area are primarily:

1. Handling/erection
2. Installation/removal of access equipment
3. Scheduled maintenance
4. Fluid system integrity verification
5. Servicing/deservicing

New technology must be applied to subsystem and vehicle design to improve both operability and maintainability of future hardware.

Examples:

1. Better compatibility/lifetime at hypergolic system soft-goods
2. Cryogenic V.J. system elimination/improvement
3. Mechanical system health measuring techniques

4. Fluid system leak check methods
5. Improved mechanical corrections for fluid systems
6. Acceptability of prelaunch failures without excessive mission risk
7. Standardized vehicle-to-payload interfaces (minimize mission kits)
8. Less critical hardware mating interfaces (mechanical and fluid)

THEME 12 - TECHNOLOGY FOR ADVANCED SPACE TRANSPORTATION SYSTEMS (ASTS)

GOAL: ASSURE TECHNOLOGY READINESS FOR AN INTEGRATED ASTS TO PERMIT EFFICIENT, RELIABLE, ROUTINE USE OF SPACE WITH A SIGNIFICANT REDUCTION OF UNIT AND TOTAL TRANSPORTATION COSTS IN THE 1985 - 2000 TIME FRAME.

- A. TOTAL REUSABILITY/MINIMAL REFURBISHMENT
- B. RESPONSIVE TO HIGH LAUNCH RATE REQUIREMENTS WHEN OPERATIONS AND ENERGY ARE PREDOMINANT RECURRING COSTS.
- C. MAXIMUM FLEXIBILITY FOR OPERATION BETWEEN EARTH AND GEO-SYNCHRONOUS ORBIT.

PRECEPT: BUILD ON STATE OF TECHNOLOGY DEMONSTRATED BY SUCCESSFUL SHUTTLE/SPACELAB/IUS OPERATIONS

RS-2

THEME 12 - TECHNOLOGY FOR ADVANCED SPACE TRANSPORTATION SYSTEMS (ASTS)

NEEDS/BENEFITS:

PERMITS MORE COST-EFFECTIVE EXPLOITATION OF SPACE

SUPPORTS: MULTIPURPOSE SPACE POWER PLATFORMS

INDUSTRIALIZATION OF SPACE

SEARCH FOR EXTRATERRESTRIAL INTELLIGENCE

EXPLORATION OF THE SOLAR SYSTEM

GLOBAL SERVICE SYSTEMS

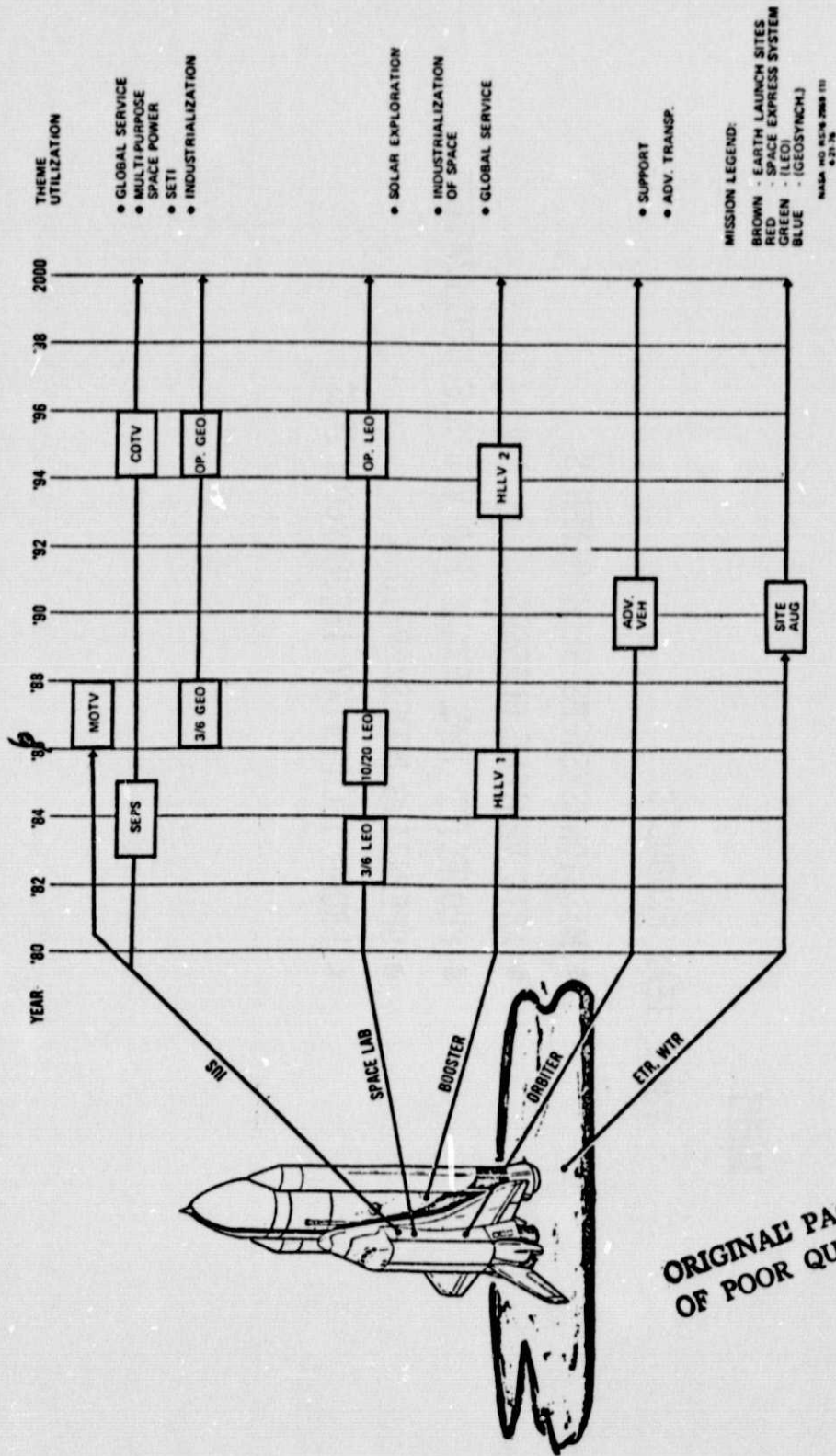
THEME 12 - TECHNOLOGY FOR ADVANCED SPACE TRANSPORTATION SYSTEM (ASTS)

INPUT

THEME TEAM PRODUCTS

- MISSION/SYSTEMS REQUIREMENTS
- ASTS VEHICLE CLASSES
- PROJECTED TIME FRAME FOR VEHICLE UTILIZATION
- OPERATING MODES/OPTIONS
- BROAD TECHNOLOGY ISSUES/CONCERNS

SPACE TRANSPORTATION SYSTEM



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ADVANCED SPACE TRANSPORTATION SYSTEM TECHNOLOGY MATRIX

FUNCTION VEHICLE CLASS		PAY LOAD	TECHNOLOGY READINESS TIME PERIOD	TIME FRAME (IOC)	TECHNOLOGY DRIVERS (ISSUES)			
					AERO- THERMO	STRUCT/ MATLS	GUID./ NAVI CONT.	POWER/ PROP. TIONS
O.T. VEH. (PERSONNEL)	3-6 MEN & > 40K P/L	1982	1987		✓	✓	✓	✓
O.T. VEH. (CARGO)	> 100K P/L	1990	1995			✓	✓	✓
HLL V ₁	200K	1980	1985		✓	✓	✓	✓
HLL V ₂	1000K	1990	1995			✓	✓	✓
ADV. VEH.	20 MEN & 30K P/L	1985	1990		✓	✓	✓	✓

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THEME 12 - TECHNOLOGY FOR ADVANCED SPACE TRANSPORTATION SYSTEM (ASTS)

OUTPUT

WORKSHOP PRODUCTS -

- SPECIFIC INFORMATION FOR TECHNOLOGY PROGRAM PLANNING FOR AN ASTS TO PERMIT COST-EFFECTIVE CONSTRUCTION/ASSEMBLY, MANNING AND LOGISTICS OF LARGE, NEAR-PERMANENT, MANNED OR MAN-TENDED FACILITIES IN LEO AND GEO.

- INCLUDE -

EARLY TECHNOLOGY NEEDS

ADVANCED STUDIES

BASIC RESEARCH

FLIGHT EXPERIMENTS

- AND

R.O.M. RESOURCE AND SCHEDULE REQUIREMENTS

THEME 12 - TECHNOLOGY FOR ADVANCED SPACE TRANSPORTATION SYSTEM (ASIS)

- AEROTHERMODYNAMICS - PARAMETRIC ANALYSES TO IDENTIFY CONCEPTS AND DEFINE SUPPORTING DESIGN AND EXPERIMENTAL EFFORTS.
- GUIDANCE, CONTROL, NAVIGATION - INCREASE EFFICIENCY OF ONBOARD SYSTEMS:
ASSESS AUTONOMOUS NAVIGATION SYSTEMS CONCEPTS: ASSESS GLOBAL POSITIONING SYSTEMS FOR NAVIGATION AIDS: ADVANCE OPTICAL ATTITUDE AND TRACKING SYSTEMS:
LASER RENDEZVOUS AND DOCKING SYSTEMS: INCREASE AUTONOMY.
- POWER - IMPROVE ENERGY CELL CONVERSION EFFICIENCY AND LIFE OF FUEL CELLS,
BATTERIES: DEMONSTRATE ADVANCED SYSTEMS, I.E., SOLAR ARRAYS, ETC.
- PROPULSION - PROVIDE BASIS FOR ADVANCED PROPULSION CONCEPTS W/HIGHER PERFORMANCE,
LESS WEIGHT, SMALLER VOLUME, LONGER LIFE USING ADVANCED SYSTEMS, COMPONENTS, ETC.
- STRUCTURES AND MATERIALS - ADVANCED MATERIALS: STRUCTURAL DESIGN CONCEPTS/
TECHNIQUES; ADVANCED THERMAL CONTROL SYSTEMS AND TPS; NDE TECHNIQUES.
- OPERATIONS* - SUBSYSTEM AND VEHICLE DESIGN TECHNOLOGY TO IMPROVE OPERABILITY AND
MAINTAINABILITY
- INTERDISCIPLINARY* - (WORK IN REAL-TIME)

*ALL WORKING GROUPS

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- Technology for Advanced Space Transportation Systems (TT-#12)

The program remains essentially the same as presented in the original theme paper, The only significant change is in the precept, which is:

PRECEPT: The Space Shuttle will commence operational use in 1980 and will provide a major improvement in space transportation economy over currently expendable space launch vehicles which will be phasing out in that period.

In-house studies have identified attractive program options for solid booster replacement or modification which could further reduce Shuttle transportation costs. This reduction could be realized in the mid-80's through a block change which would cause little impact on the Orbiter. It is the booster system which has the greatest effect on cost per flight, therefore OSF has initiated studies for Shuttle growth to analyze these booster options and further quantify the operational cost savings achievable and investment required for each option. OAST work will be taken into consideration in the Shuttle Growth Studies.

For the purposes of identification of requirements for technology for an integrated Advanced Space Transportation System, the state-of-technology of the Shuttle systems available in 1985 will be considered as the base for this effort.

OVERALL THEME TECHNOLOGY RANKING AND
INITIATIVE ACTION

TT Advanced Transport System - 12

Page 1

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TECHNOLOGY NEED NO	OVERALL T.T. PRIORITY	INITIATIVE ACTION		
		REVISE EXISTING INITIATIVE	DRAFT NEW INITIATIVE	NONE REQUIRED
Materials for advanced propeller 12-M1-6	1			
TPS 12-M1-1	2			
High-strength alloys and comp. 12-M1-2	3			
Metalics and chem. envior. 12-M1-4	4			
NDE/NDT struct. 12-M1-5	5			
Thermal control sys./mat. 12-M1-3	6			
Advanced vehicle structures 12-M2-2	1			
Recovery and ldg. techniques 12-M2-1	2			
Orb assembly of modules 8-M2-4	3			
In-service NDE/NDT 12-M2-3	4			
P/L dynamics and acoustics 12-M1-5	5			
Damage tolerance 12-M2-6	6			
Veh. loads anal. and opt 12-M2-4	7			

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OVERALL THEME TECHNOLOGY RANKING AND
INITIATIVE ACTION

TECHNOLOGY NEED NO	OVERALL T.T. PRIORITY	INITIATIVE ACTION		
		REVISE EXISTING INITIATIVE	DRAFT NEW INITIATIVE	NONE REQUIRED
Auton. pmg. and sch. tools 12-E4-4	1			
S/W for sys. integrity 12-E4-9	2			
Itell. exec. programs 12-E4-12	3			
Simulation 12-E4-17	4			
Teleoperator support S/W 12-E4-3	5			
Auton. G&C of LV 12-E1-1	3			
Auton. NAV earth orbiters 12-E1-5	3			
Auton. ops. and mission modif. 12-E1-11	3			
Low-thrust G&N 12-E1-13	5			
Auton. ren. and docking 12-E1-14	2			
Checkout, self test and repair 12-E1-18	4			
Dyn. & cont. of manned entry veh. 12-E1-27	1			

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OVERALL THEME TECHNOLOGY RANKING AND INITIATIVE ACTION

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TECHNOLOGY NEED NO	OVERALL T.T PRIORITY	INITIATIVE ACTION		
		REVISE EXISTING INITIATIVE	DRAFT NEW INITIATIVE	NONE REQUIRED
High pl engine 12-P1-30 12-P1-23	1			
H/O propulsion 12-P1-22	2			
SSME growth 12-P1-17 12-P1-31	3			
Dual fuel engine 12-P1-34	4			
Cryo. storage & transfer 12-P1-7 12-P1-1	1			
L/H engine 12-P1-26	2			
Dual fuel engine 12-P1-2	3			
LOX/HC engine 12-P1-21	1			
L/H low thrust 12-P1-8	2			
L/H high thrust 12-P1-20	3			
MPD thrusters 12-P1-12	1			
Ion thrusters 12-P1-13	2			
Peristojet 12-P1-11	3			
Lasers 12-P1-16	4			
Low-cost/lightwt. eng. comp. tech. 12-P1-56	?			

- P-1, LV

P-1, OTVM

P-1, Aux. pro

P-1, OTVC

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[illegible]